

METHOD AND APPARATUS FOR TREATING LIPID-CONTAINING WASTE WATER USING MICROBES

TECHNICAL FIELD

The present invention relates to a method and apparatus for treating lipids contained in waste water.

BACKGROUND ART

In conventional decomposition treatments such as surface aeration, scum having a high oil content does not easily decompose, and is thus collected as floating scum to be separately discarded. Regarding the grease traps provided in restaurant kitchens as well, the scum having a high oil content rises and accumulates at the top, where it can give off foul odors and must be periodically separated to be discarded.

Additionally, while there have been proposals for promoting decomposition of lipids in grease traps by means of microbes (Japanese Patent Application, First (*kokai*) Publication No. 2004-188405), microbes have difficulty performing well in the environment of a grease trap, and even if lipid-decomposing microbes are introduced, most of them will be gradually drained away together with waste water, so their effects do not last.

DISCLOSURE OF THE INVENTION

In view of the above, the present invention has the purpose of offering a method and apparatus that reduces the outflow of oil-decomposing microbes, promotes growth of oil-decomposing microbes, and further allows efficient decomposition of lipids by microbes.

The present invention offers a waste water treatment method in a waste water

treatment apparatus comprising a grease trap or a waste water decomposition treatment tank, a decomposition tank containing a carrier consisting of a porous material carrying oil-decomposing microbes, and aeration means for aerating said decomposition tank; the method comprising steps of transferring scum containing oils from said grease trap or waste water decomposition treatment tank to said decomposition tank; in the decomposition tank, bringing the scum into contact with and fixing it onto said carrier, and draining water; and aerating the decomposition tank to cause the oil-decomposing microbes to decompose the oils contained in the scum in an aerobic environment.

In the present specification, the expressions "grease trap" and "waste water treatment tank" refer to apparatus for capturing solid or semisolid lipids in waste water so that they will not be drained away, typical examples of which include those for the purpose of treating waste water from kitchens, although the expressions are not limited thereto and include those for the purpose of treating waste water from commercial and industrial facilities.

The expression "oil-decomposing microbes" refers broadly to microbes having the ability to decompose lipids, and in the present invention, these may be yeasts, koji molds or *Bacillus subtilis*. The use of koji molds or yeasts is preferable because they do not generate foul odors. In particular, *Pichia farinosa*, which has high lipid-decomposing ability in aerobic environments, and more preferably the yeast deposited as NITE P-287, can be used. The carrier for the microbe preferably has high porosity, and examples include zeolites, sponges, paper and cotton. Such porous carriers are capable of absorbing oils, so that the microbes collected in the carriers can decompose the oils. Additionally, they have the advantage that when performing surface aeration in the decomposition tank, gases will adhere to the carrier, thus improving the growth and activity of the aerobic microbes. Furthermore, the porous carrier should preferably have an affinity to lipids. This is because it enables microbes to be more easily fixed by capillary action.

While aeration means for aerating the decomposition tank may be means for blowing air such as those using fans, they may also be means for aeration by natural ventilation, such as aeration means consisting of exhaust towers and ducts, as long as it is capable of providing the air necessary for the microbes to decompose oils.

In the present invention, the expression "scum" refers to solids, semisolids, clumps of highly viscous fluid, floating debris and mixtures thereof. When transferring the scum to the decomposition tank, it may be transferred to the decomposition tank together with substances other than scum such as water or the like. The means for doing so may require a power source such as a pump, or the structure may make use of gravity in such a way that only the overflow is transferred to the decomposition tank. Additionally, the scum may be transferred to the decomposition tank continuously or in batches. Furthermore, at that time, it is possible to transfer all of the waste water in a grease trap or waste water treatment tank to the decomposition tank, or to transfer only the portions of the waste water containing large quantities of scum, such as only the portion floating on the top.

The carrier carrying the oil-decomposing microbes may be brought into contact with the scum by means of a method of providing multiple carrier pieces inside the decomposition tank and dumping scum or waste water containing scum onto the carrier pieces from above, or a method of providing a carrier of roughly the same size and shape as the horizontal cross section of the decomposition tank and dumping scum or waste water containing scum onto this carrier. When draining the water, it is generally preferable to drain the water from the bottom of the decomposition tank, but in the case of a tubular decomposition tank that is long in the horizontal direction, it is possible to feed scum or waste water containing scum from one end and drain the water from the other end. By using a porous carrier as a filter, and draining the water that has passed through the pores, the scum can be efficiently trapped while draining the extra water.

The aeration of the decomposition tank may be performed after draining the water, or for example, aeration can be performed from the side portions of the decomposition tank while continuously draining water from the bottom of the decomposition tank. Aeration enables some of the water to be kept inside the carrier while also preventing the carrier from becoming completely immersed in water, thus creating a favorable environment for aerobic fermentation.

The invention also offers a waste water treatment apparatus comprising a grease trap or a waste water decomposition treatment tank; a decomposition tank containing a carrier consisting of a porous material carrying oil-decomposing microbes; aeration means for aerating said decomposition tank; transport means for transferring scum containing oils from said grease trap or waste water decomposition tank to said decomposition tank; and water drainage means for draining water from the decomposition tank; wherein in the decomposition tank, the scum is brought into contact with and fixed onto said carrier, and the water drained; and the decomposition tank is aerated to cause the oil-decomposing microbes to decompose the oils contained in the scum in an aerobic environment.

The transport means may, for example, comprise partitions erected so as to stand upright from below inside said grease trap or waste water decomposition tank; and a pump and pipe to direct scum containing oils from inside the space enclosed by the partitions to said decomposition tank. The partitions erected so as to stand upright from below may be directly erected on the bottom of the grease trap or waste water decomposition treatment tank, or may be in the form of a box that is open at the top and having its own bottom separate from the grease trap or waste water decomposition treatment tank.

When a certain amount of waste water fills the grease trap or waste water decomposition tank, the surface of the waste water is positioned higher than the top edges of the partitions erected at the surface of the waste water. When a pump is activated in this condition to pump out the scum containing oils from the space enclosed by the partitions, the

scum that is floating higher than the top edges of the partitions will pour into the space and will thus be collected more easily. Therefore, the top edges of the partitions should preferably be positioned lower than the top edges of the grease trap or waste water decomposition treatment tank, at a position suitable for selectively removing the scum.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic showing a grease trap.

Fig. 2 is a schematic showing how the scum rises to the top in a grease trap.

Fig. 3 is a comparison of the digestive ability of normal hexane extracts by solid state fermentation and liquid state fermentation.

Fig. 4 is a schematic showing a waste water treatment apparatus based on one embodiment of the present invention.

Fig. 5 is a schematic showing a waste water treatment apparatus based on one embodiment of the present invention.

Fig. 6 is a schematic showing a waste water treatment apparatus based on another embodiment of the present invention (with the grease trap filled with waste water).

Fig. 7 is a schematic showing a waste water treatment apparatus based on another embodiment of the present invention (with the waste water from the grease trap transferred to the decomposition tank).

Fig. 8 is a schematic showing a waste water treatment apparatus based on another embodiment of the present invention (with water not containing scum being returned from the decomposition tank to the grease trap).

Fig. 9 is a photograph showing the decomposition of waste water by a waste water treatment apparatus based on an embodiment of the present invention.

MODES FOR CARRYING OUT THE INVENTION

Herebelow, a preferred embodiment of the present invention shall be described.

In the grease traps in restaurants and the like, scum that has a high oil content normally has a lower specific gravity than water and therefore rises. Therefore, by placing an obstructing walls on the drainage path so as to allow outflow from only the bottom portion, the scum can be trapped at the top as shown schematically in Fig. 2. In this state, the scum or waste water containing scum can be transported to a decomposition tank using a pump.

A carrier consisting of a porous material carrying oil-decomposing microbes is provided inside a reaction tank. Scum is supplied from above or below the carrier, and the water is drained from under the carrier (the bottom of the reaction layer). This operation causes oils and fats to remain fixed to the carrier, where they are decomposed by the oil-decomposing microbes. The drained water may be returned to the grease trap. Furthermore, it is possible to provide multiple reaction layers in a cascade, so that the water released from a first reaction layer is supplied to a second reaction layer where the oils are further decomposed.

Fig. 6 is a conceptual diagram showing waste water that has been collected in a grease trap according to another embodiment of the present invention. Inside the grease trap, partitions are erected so as to stand upright from below, and the surface of the waste water is positioned higher than the upper edges of the partitions. Since the scum in waste water usually has a specific gravity of less than 1, it will be floating on the surface of the waste water.

Fig. 7 shows how waste water containing scum is transferred to a decomposition tank using a pump provided in the space contained by the partitions. At this time, the waste water in the space enclosed by the partitions is pumped out. The waste water in the space is

removed to allow the scum floating on the surface of the grease trap to flow into this space, from where it is transferred to the decomposition tank. In this way, the scum floating near the surface of the grease trap can be efficiently transferred to the decomposition tank.

Fig. 8 is a schematic showing how the water remaining after decomposition of the scum in the decomposition tank or the water left after filtering the scum by means of the carrier in the decomposition tank is returned to the grease trap. While the structure here is such that the water is returned to the grease trap, the water which no longer contains scum may be directly released as sewage or the like.

Fig. 9 is a photograph showing the results of performing the above steps on an actual grease trap. Before the treatment, a large amount of scum is floating on the surface of the waste water, but by transferring (removing) the waste water to a decomposition tank, most of the scum can be removed, so that no scum can be observed in the grease trap upon returning the waste water after the decomposition treatment.

In order to decompose the oils in waste water, the conventional art employed a free-flow decomposition method in which oil-decomposing microbes are scattered in the waste water to make a liquid culture in an aerobic or anaerobic state, but this method causes the oil-decomposing microbes to be drained out together with the flow of water, and thus tends to have poor efficiency over time. Additionally, the speed of decomposition often cannot keep up with the influx of oil, causing a buildup of scum, and requiring a physical removal operation. The present invention allows scum to be efficiently eliminated, and the efficiency of decomposition to be improved by causing the microbes to adhere to a sponge with a high affinity to oils or oil-adsorbing fibers, and aerating.

[Experiments]

The following experiments were performed to confirm the effects of the present

invention.

Experimental Method

A sponge was caused to absorb a culture simulating waste water and olive oil, then sterilized and inoculated with a *Pichia* culture solution. After cultivating for three days, olive oil was added, and the quantity of matter extractable by normal hexane was compared immediately after addition and after cultivating for an additional 24 hours (hereinafter referred to as "solid state fermentation"). Separately, a sponge which was caused to absorb a culture simulating waste water and olive oil, then sterilized and inoculated with a *Pichia* culture solution, was placed in a glass bottle, sterilized and inoculated with a *Pichia* culture solution. After cultivating for 24 hours, olive oil was added, and the quantity of matter extractable by normal hexane was compared immediately after addition and after cultivating for 24 hours (hereinafter referred to as "liquid state fermentation").

Experimental Results

The values after cultivating for 24 hours are shown in the following table and the graph in Fig. 3, which is normalized such that the amount of normal hexane extracts immediately after adding olive oil is adjusted to be equal to 100.

TABLE 1 Comparison of Digestive Ability of Normal Hexane Extracts by Solid State Fermentation and Liquid State Fermentation

	Solid State Fermentation	Liquid State Fermentation
Immediately after adding oils	100.0	100.0
After 24 hours	34.5	95.2

The lipid digestive ability of *Pichia* in the case of solid state fermentation was found to be significantly higher than in the case of liquid state fermentation. This suggests that solid state fermentation using the lipids in waste water from a grease trap and a sponge composed of

a starch is possible. The tests were performed with 10 g of lipids with respect to 100 ml of water in the case of liquid state fermentation and with 40 g of lipids with respect to 50 g of sponge in the case of solid state fermentation, in which case the sponge held 40 ml of water therein.

[Examples]

As shown in Fig. 4, an underwater pump was installed in a grease trap, the waste water in the grease trap was pumped up, and transferred to a tank filled with sponges to which oil-decomposing bacteria were fixed.

After enough of the scum was transferred to the tank, the pump switch was turned off. Then, the SS and oils contained in the waste water in the tank were absorbed by the sponge and remained in the tank (Fig. 5). In this state, the decomposition tank was continuously aerated from the bottom. A waste water pumping operation was performed three times daily, in the morning, at midday and in the evening. As a result, the normal hexane value of the oils contained in the waste water, which was 25,000 ppm before pumping, was reduced to 20 ppm after pumping.

This operation was continued for 30 days. During this time, not only were the oils in the grease trap decomposed by the microbes fixed to the sponge, but also, the sludge from garbage other than oils was also decomposed. The amount of oil contained in 1 g of sponge was found to be constant at 15 g, the oils contained in the waste water being stably decomposed. Furthermore, these grease traps normally have mesh cages for separating out the raw garbage, with an average of 100 g of residues being generated daily. While the present test was performed with the mesh cage removed, no scum from raw garbage was observed. It can be inferred that the scum from raw garbage was also absorbed into the sponges in the solid state fermentation treatment tanks and decomposed by fermentation. During this one-month

testing period, the grease trap and solid state fermentation tank did not generate any foul odors or scum.

The microbes used for this technology may be of any type as long as the microbe is capable of breaking down oils. In other words, more than ten-fold treatment efficiency was achieved as compared with liquid state fermentation, whether using the oil-decomposing yeast *Pichia* which was discovered by our company, koji mold, or *Bacillus subtilis*, although there were slight differences therebetween. The carrier for fixing the microbes may be of any material which has an affinity to oils and is porous. Similar effects were observed in polypropylene sponges, filtering sponges for aquariums, and oil-adsorbing fibers. Additionally, similar effects were obtained even when using corn cobs taken from maize.

CLAIMS

1. A waste water treatment method in a waste water treatment apparatus comprising a grease trap or a waste water decomposition treatment tank, a decomposition tank containing a carrier consisting of a porous material carrying oil-decomposing microbes, and aeration means for aerating said decomposition tank; the method comprising steps of:

transferring scum containing oils from said grease trap or waste water decomposition treatment tank to said decomposition tank;

in the decomposition tank, bringing the scum into contact with and fixing it onto said carrier, and draining water; and

aerating the decomposition tank to cause the oil-decomposing microbes to decompose the oils contained in the scum in an aerobic environment.

2. A waste water treatment method in accordance with claim 1, wherein said carrier is provided such as to partition the interior space of said decomposition tank, and the scum is transferred to one of the interior spaces of the decomposition tank partitioned by said carrier, while the water is drained from another interior space.

3. A waste water treatment method in accordance with claim 1 or 2, wherein said oil-decomposing microbe is a yeast.

4. A waste water treatment method in accordance with claim 3, wherein said oil-decomposing microbe is *Pichia farinosa*.

5. A waste water treatment method in accordance with claim 4, wherein said oil-decomposing microbe is the yeast deposited as NITE P-287.

6. A waste water treatment apparatus comprising:

a grease trap or a waste water decomposition treatment tank;

a decomposition tank containing a carrier consisting of a porous material carrying oil-decomposing microbes;

aeration means for aerating said decomposition tank;

transport means for transferring scum containing oils from said grease trap or waste water decomposition tank to said decomposition tank; and

water drainage means for draining water from the decomposition tank;

wherein in the decomposition tank, the scum is brought into contact with and fixed onto said carrier, and the water drained; and

the decomposition tank is aerated to cause the oil-decomposing microbes to decompose the oils contained in the scum in an aerobic environment.

7. A waste water treatment apparatus in accordance with claim 6, wherein said transport means comprises partitions erected so as to stand upright from below inside said grease trap or waste water decomposition tank; and a pump and pipe to transfer scum containing oils from inside the space enclosed by the partitions to said decomposition tank.